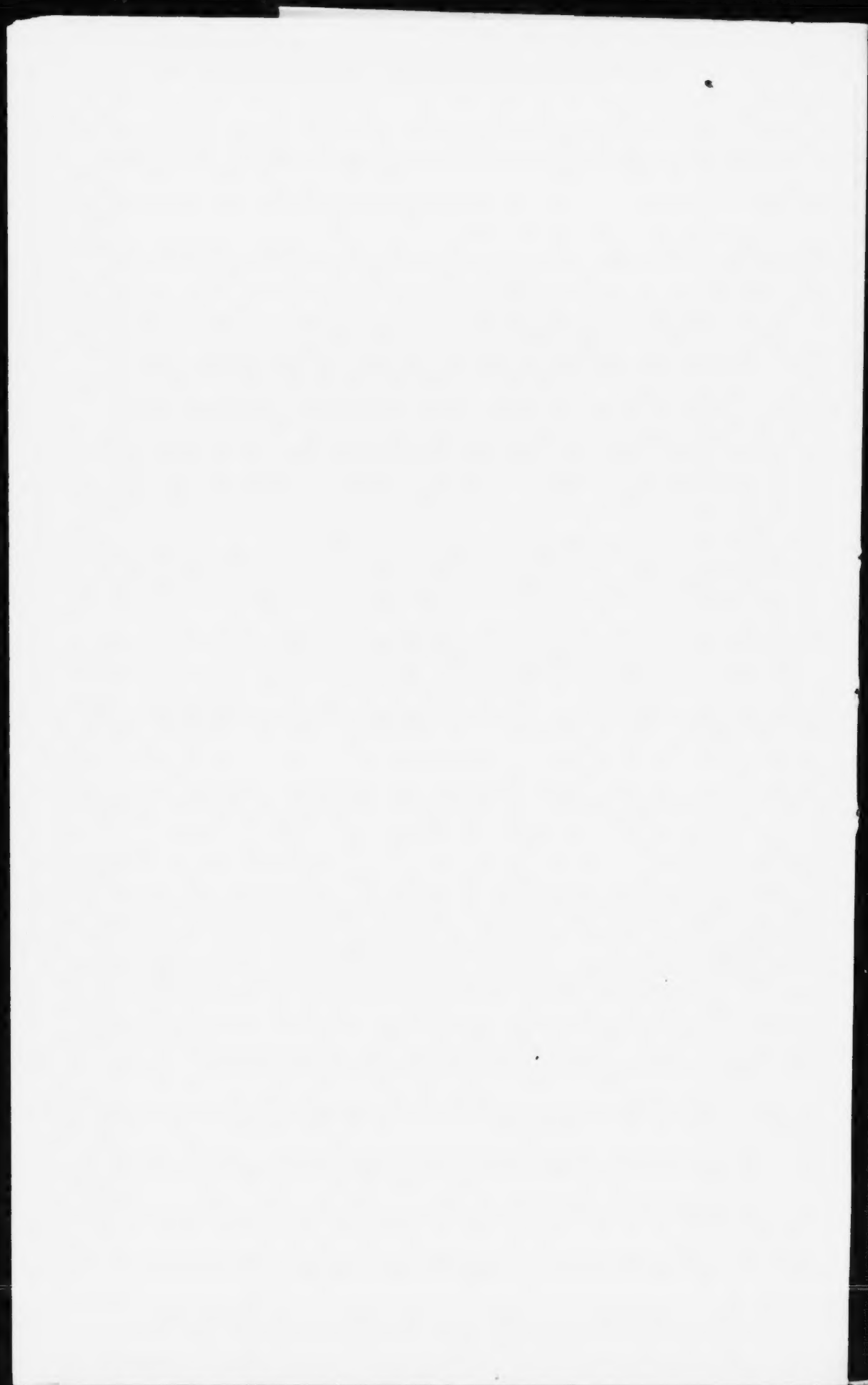




ADDENDA TO REPORT

OF THE

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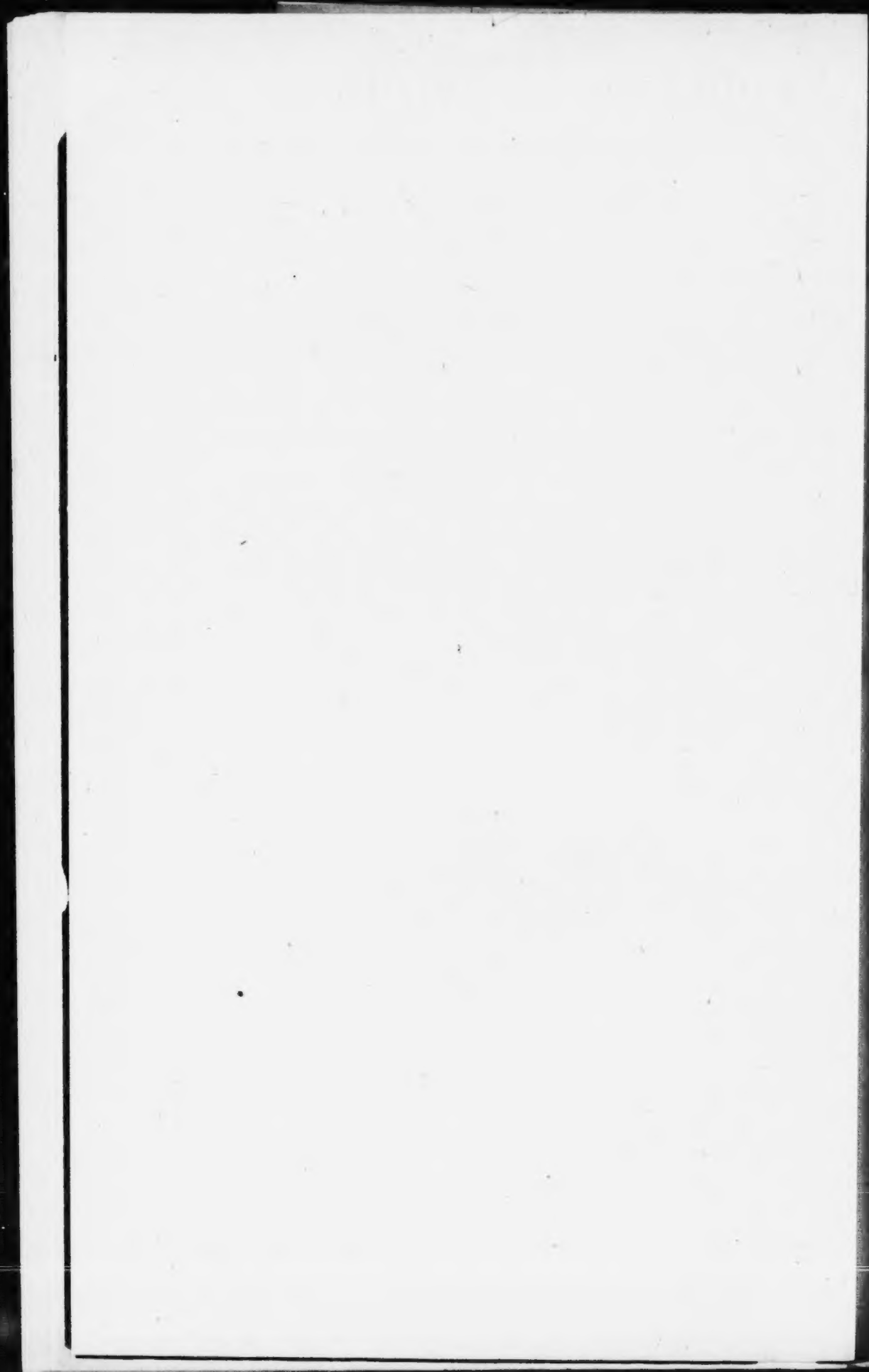
INTERCOLONIAL RAILWAY.



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1870.



ADDENDA TO REPORT
OF THE
COMMISSIONERS
OF THE
INTERCOLONIAL RAILWAY.

[BB.]

To the Honorable Sir JOHN A. MACDONALD, K.C.B.,
Minister of Justice, &c., Ottawa.

SIR,—Having been favored with the opportunity of perusing a paper submitted to the Privy Council by the Commissioners of the Intercolonial Railway, bearing date the 26th January, 1869, I trust you will permit me to make a few observations on the subjects embraced in that paper. It refers to and criticises the views laid before you in an unofficial letter which I had the honor to address to you on the second of January last. In that letter I had undertaken to state the grounds on which I preferred a system of schedule prices to that of a lump sum in the contracts to be let in respect to the Intercolonial Railway.

The few remarks which I now beg permission to offer seem to me to be required in justice to myself in reference to certain conclusions arrived at by the Commissioners, which are very much at variance with those which I had come to. I trust you will see they are not conceived or urged in a spirit of controversy.

The principal aim of the letter to you, which the Commissioners have made the subject of their observations, was to show that in the circumstances under which this work was to be undertaken, the system of contracting which I considered most in accordance with the public interests, was that which is based on a schedule of prices, the contractor undertaking to do any work which might be given him, within the limits of his contract, at a fixed rate for each kind and quality of work, instead of the lump sum system, by which the contractor agrees for a round and determinate sum to construct an entire section or portion of road within defined limits.

One principal reason which I had in the present case for preferring the system I recommended, was, that the surveys on the Intercolonial Railway running as they do, over a space of over 500 miles had been set on foot only within a few months, that though they had been prosecuted ever since with all possible diligence, they were still in a very

incomplete state, and not sufficiently advanced to enable the Commissioners to furnish to intending contractors such information as was required for making Tenders at all based upon the amount and character of the work undertaken, and that, in the absence of such information, Tenders would be to a large extent a mere matter of conjecture; that particularly as regards the bridges and numerous structures over rivers and streams crossing the line, no opportunity had occurred since the organization of the survey, to obtain the information absolutely necessary before venturing to fix with precision their size, span, character, or the nature of their foundations, and that the only time when such information was obtainable, was when by the melting snows of spring the extent to which the streams were liable to be swollen by freshets could be seen, and the material be thus furnished to enable the Engineer to determine the extent and size of the necessary structures.

The Commissioners in reference to the condition of the survey, say, in their paper, that if the surveys are not so far advanced as to enable the Engineer "to give contractors statements of quantities upon which to base their tenders, he is equally unable to afford the Commissioners any satisfactory information in regard to the different quantities and the various kinds of work to be executed," and they add "the result then would be, that if the Commissioners receive a number of tenders based upon a schedule of prices, such schedule of prices covering, according to Mr. Fleming's proposal, no less than twenty-nine different items, they would be utterly unable to decide which tender it was most desirable to accept, and have no data whatever upon which to found any calculations in regard to the relative economy or otherwise of the different tenders," and to show that on such a system "it would be impossible to form any idea at all as to which was the most advantageous tender," they proceed to construct a table in which they group the data furnished by such tenders, so as to exhibit the impossibility of deducing from them any practical conclusion, they add that "no estimate ever could be made as to the most desirable tender unless the quantities were known, and this information Mr. Fleming states he cannot supply."

If the system I recommended were really open to the objections so alleged by the Commissioners, it would be indefensible, but in reality there is no difficulty in ascertaining the relative value of tenders on a schedule of prices with a tolerable degree of exactness under circumstances like the present; it is commonly done by assuming quantities based on the best data obtainable, and carrying out these, at the prices given in each tender, the total sums give the comparative or relative value of each tender. The following is an example:

QUANTITIES, &c.	Tender, No. 1.		Tender, No. 2.		Tender, No. 3.		Tender, No. 4.		Tender, No. 5.	
150 acres clearing ..	16 00	2,400 00	20 00	3,000 00	12 00	1,800 00	15 00	2,250 00	14 00	2,100 00
10 acres close cutting	20 00	200 00	10 00	100 00	12 00	120 00	17 00	170 00	8 00	80 00
10 acres grubbing ..	80 00	800 00	60 00	600 00	70 00	700 00	100 00	1,000 00	90 00	900 00
80,000 cubic yards rock excavation ..	1 20	96,000 00	0 90	72,000 00	0 95	76,000 00	1 25	100,000 00	1 10	88,000 00
700,000 cubic yards earth excavation ..	0 27	189,000 00	0 31	217,000 00	0 30	210,000 00	0 26	182,000 00	0 32	224,000 00
600 chains drains ..	13 00	7,800 00	14 00	8,400 00	16 00	9,600 00	15 00	9,000 00	18 00	10,800 00
400 cubic yards concrete	7 00	2,800 00	3 00	1,200 00	6 00	2,400 00	4 00	1,600 00	5 00	2,000 00
3,500 cubic yards 1st class masonry ..	11 00	38,500 00	12 00	42,000 00	11 50	40,250 00	10 00	35,000 00	13 00	45,500 00
4,000 cubic yards 2nd class masonry ..	7 00	28,000 00	8 50	34,000 00	7 00	28,000 00	8 00	32,000 00	9 00	36,000 00
Et ceteras, say		73,100 00		75,660 00		76,774 00		72,604 00		81,876 00
Totals		438,600 00		453,960 00		442,644 00		435,624 00		491,256 00

The total sums obtained by these prices will give the relative value of the different tenders, even though the quantities should turn out to be not strictly correct. The accuracy of the quantities is really of little consequence in a comparison of tenders, as they are applied in the same way to each tender. For example, should the quantities turn out to be 10 or 20 per cent. too great or too little, the totals would all in the same ratio be absolutely too great or too little, but in relation to each other these totals would, for all practical purposes, remain unchanged.

It would, no doubt, be improper to assume in the comparison impossible or extravagant quantities,—this course is not necessary,—although the data furnished be insufficient to enable any one to make an exact estimate of quantities, information, such as that in possession of the Commissioners, is quite enough to enable them practically to compare the value of tenders on a schedule of prices with perfect accuracy.

The Commissioners are of opinion that the adoption of the system of schedule prices "would be certain in the end to lead to endless disputes, owing to difference of opinion between the Contractor and the Engineer, in regard first, to the quantities of each description of work executed, and then in regard to the classification of items according to the Tender under which it was to be paid for," but the Commissioners do not seem to have considered that there can be no disputes between the Engineer and Contractor in regard to quantities of work executed, if the Contract as is usual in such cases, makes the decision of the Engineer final as to quantities, but even if it does not, the matter would be speedily settled by a re-measurement by both parties. If cross-sections of the earth-work are made before the work is commenced, and exact drawings of all mechanical structures as they are executed, no material difference can possibly arise between the parties; in fact, as regards quantities, these could be ascertained with mathematical precision, while, as regards classification of work done, no serious difference could possibly arise, if the simple and clear definitions adopted in the original specification were adhered to.

The Commissioners urge that the certificates of the Engineer, upon which, under the system of schedule prices, Contractors are ultimately to be paid, could not be founded on the personal knowledge of the Chief Engineer; that the duty of making these measurements would practically devolve, as a matter of necessity, upon the youngest Engineers, who were brought into immediate contact with the Contractors, and that, therefore, there could be no reliance upon the accuracy of surveys made by such persons, and under such circumstances; but in point of fact, the measurement of the works mainly devolves on the Division Engineer and his two assistant Engineers, and no one should be appointed to or kept in either of these offices, without high character and sufficient experience.

Under a proper organization and system of measurements and records, any erroneous return of quantities could readily be detected by the District Engineer, by the Chief Engineer, or by any one else appointed by the Commissioners.

The Commissioners express "their regret that after Engineers have been so long engaged in preparing the plans, and have had necessarily so many months opportunity to judge of the sizes of the streams, and of obtaining information on the subject from the people in the country, they are now unable to give anything like definite information as to the size of the structures to be put up." It is but right to say in reply, that the Engineers have been but a short time preparing the plans, most of their time has been engaged in making explorations, preliminary surveys, and subsequently in locating the line; when so engaged, the Engineers were seldom more than a few days in one locality, and they have had no opportunity of observing the flood level of the streams. It is only in the spring when the water channels are flooded with melted snow, and after the line is located and divided into Districts, and after District, Division, and Assistant Engineers have been appointed, and stationed at their different posts, that the necessary information respecting streams can properly be obtained. I am now taking steps to procure this information, but the opportunity never presented itself before. I may add, that as regards many of the streams to be spanned, we have not had the advantage which a settled country affords. In that case, information of some kind, even if not entirely accurate or reliable,

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can be obtained from the inhabitants; but the sites of many of the bridges and culverts on this line, are in places where there are no inhabitants, and where, therefore, information of the character of the stream to be spanned is not obtainable in the neighborhood.

The Commissioners express themselves at a loss to understand upon what principle the plans are made to show culverts and bridges of varying sizes and dimensions, if the necessary information has not already been procured, but the bridges and culverts marked on the plans cannot be understood to be determined on. They are marked of such varying sizes and dimensions, as the locating engineers under the circumstances above described conjectured, with the very limited information they possessed, might be suitable; and they are only given to enable contractors to form some idea of what might possibly be required, in order that they might make their calculations and arrangements with regard to the supply of stone and other materials.

The Commissioners are of opinion that to attempt to carry out the system of schedule prices would lead to disaster, and they make this declaration more emphatic, by repeating it in another part of their paper in almost the same form, but I confess I do not see how that is possible, when it is the very essence and foundation of the system in question, that no work shall be done except what the Commissioners wish, and that the Contractor shall be paid for what he does, and that only, and paid at the price which by Tender is fixed as the lowest at which it can be done.

"The Commissioners believe from the examination that they have made, and the plans and profiles prepared, that Contractors will have no difficulty whatever in forming their own opinion as to the amount of work to be executed upon each section," but no intending Contractor can possibly know more of the work to be done than the Engineers who have been engaged on the survey, and at the present moment even they can do little more than make a guess at the quantities, how then can intending Contractors arrive at a closer result? Many of them have never been on the ground at all, and not a few of those who have visited the localities have driven rapidly along the public road, only catching glimpses of the line at intervals.

The Commissioners are of opinion that "parties would be found to tender, on a schedule of prices who have no experience or knowledge of the work which they would have to execute, they would put in tenders at very low prices per yard for the different description of work, trusting to be able in the long run to establish claims for 'extras,' and to use political influence to get such claims allowed;" they say "that according to the conditions of contract, and the contract which the Commissioners propose to have executed, all such claims will be rendered impossible, the contractor being compelled by the terms of his contract to complete the work for the specific sum at which he tenders to do it." I think I have pretty conclusively proved in the letter which I had the honor to address to you on the 27th day of January last that the result would be diametrically opposite. The schedule system does not admit of extras. A lump sum contract, unless it clearly and minutely describes everything intended to be done invariably leads to them. It may almost be laid down as an axiom that everything which is not particularly defined in the specification or represented on the plans, will be claimed to be outside of the contract, and therefore constitute what is called extra work. Experience goes to prove that no contract, however stringently worded, can debar a contractor from obtaining compensation for work done in excess of what is shown on the plans, or otherwise defined. In the case in question, much of the work cannot be defined, because what is actually required is not yet known.

The Commissioners say that the Great Western Railway cost not less than 50 per cent. beyond the amount it was originally supposed it would cost, and they ascribe this excess to the fact that the "contracts specified no definite sum for which the works were to be constructed," being "the same course which Mr. Fleming proposes to adopt in regard to the Intercolonial Railway." The Great Western may have cost 50 per cent. more than the Engineer's estimate, but it does not follow that letting it by a schedule of prices was the cause. It is, indeed, highly probable that had the Directors of that Company placed the work under lump sum contracts (with the insufficient data which

they had in their possession at the time, and with all the changes that were made during construction); this line would have cost for litigation, arbitration, and extras a great deal more. The advantages of the system of letting by schedule of prices under circumstances like those in the present case, notwithstanding what may have occurred on the Great Western Railway, are sufficient to enable it to stand on its own merits; but it is scarcely fair to bring the cost of the Great Western Railway over the Engineer's estimate, as a charge against this system. It was generally believed by those not connected with this company that the Engineer's estimate was made low purposely, in order to get the stock taken up, and thus secure the construction of the work, and it was also commonly understood at the time that the management during construction was not of the most perfect description; be this as it may, the Directors give their explanation of the various causes which led to the large increase of cost in their report dated Sept. 29, 1854; by reference to this report, of which an extract is annexed, it will be seen that they give a variety of reasons for this excess, but I do not perceive that the schedule system of contract is one of them. They certainly allude to it, but not to condemn it or express regret that the lump sum system had not been adopted. They disapprove of the plan of paying different prices for different kinds of earthwork; and in this I fully agree with them.

The Commissioners give in their paper a short extract from the Report of the Directors of the Great Western Railway alluded to, but as I am desirous that you should have the fullest information on every point which bears on the important question under consideration, I have appended to this letter the whole of that portion of the Report which refers to the subject mentioned by the Commissioners.

On reading this document you will find that the Directors of the Great Western Railway attributed the increased cost of their line above all previous calculations to an important change in the route of the railway. By this change the line, instead of following the level table land from Niagara Falls in a direct line to Detroit, was carried down the mountain side to the level of Lake Ontario at Hamilton, and in consequence to ascend again to its original position; thus involving the construction of enormously expensive works over forty-two miles, and which were not originally contemplated.

They also give as another reason an extraordinary advance which took place in the price of material, land, labour, provisions for men and horses, and in everything relating to the construction of a railway. They also state that the iron and permanent way cost a great deal more than was originally calculated. They say that a very large increase took place in the supply of rolling stock. They further intimate that they were led astray by basing their original calculations of cost on estimates of quantities which they required the Engineer to furnish before accurate data was obtained. They adduce other reasons why their line of railway cost so much more than the Engineer's original estimate, but, if I read their report correctly, they do not say that the schedule system of contract was the main reason or any one of the reasons.

The Commissioners allege that "so strongly did the Great Western Company feel the mistake which they had made in the letting of their contracts for the main line, that when they came to construct their branch from Hamilton to Toronto they let it for a lump sum without any schedule of prices, and when the state of the surveys was far less satisfactory and forward than is the case for those portions of the Intercolonial Railway now to be let. In the same way, when they subsequently let the contract for the construction of their Sarnia Branch, they adopted the lump sum principle and abandoned the schedule of prices. In both these cases, namely, the Hamilton and Toronto and Sarnia Branches, the works were completed on the terms of the contract and for a lump sum, and no serious dispute arose afterwards in regard to claims for extras."

The Hamilton and Toronto Railway, although now purchased by and incorporated with the Great Western Railway Company, was originally established by another Company. It was understood at the time that this latter Company entered into a private contract with a well known English Contractor to construct and completely finish the line for a certain fixed lump sum, one of the primary conditions of this contract was, that he should

subscribe the capital of the Company. Under these circumstances, it is not difficult to perceive that he was in a position to stipulate his own price for doing the work which was virtually *his own work*, and it is not to be wondered at, that no serious disputes arose in arriving at a settlement. This line subsequently passed into the hands of the Great Western Railway Company, and I believe I am correct in stating that although the original contractor undertook to finish it for a fixed round sum, it cost not less than \$400,000 in addition to complete it. The Sarnia Branch I believe was similarly let by private contract at a very large price, although the works of construction were notoriously light.

The Commissioners say that "the different sections of the Grand Trunk Railway were all contracted for at the rate of so much per mile, and in no case was work executed on a schedule of prices." But the chief contractors on the Grand Trunk were, as every one knows, the financiers of the Company and had to find the capital, while the contracts for the actual construction of the work were as a rule based on quantities and prices in the usual way that such works are executed, and they were generally entered into as private agreements, competent contractors having been selected to perform the work at remunerative prices.

With regard to the Western Extension Railway from St. John, N. B., to Bangor in Maine. The circumstances were not unlike those above described and very different from those which obtain on the Intercolonial Railway. The contractors employed to execute the work were selected on account of their practical knowledge and integrity; private bargains were made with them at prices which were believed to be remunerative by both parties, and on terms considered mutually advantageous. There was no public competition in this case, the contracts were let as on the Grand Trunk Railway by private bargain.

In reference to the contract for a portion of the Wellington, Gray, and Bruce Railway which the Commissioners say has recently been made for a lump sum, I may say that this contract was let exactly on the system which I have described as the English system. A Bill of quantities was prepared and submitted to Contractors. To this they applied their prices and thus made up a bulk sum. A Schedule of prices accompanied their tender as a guide for payments of work performed, the system is explained in the following clause in the terms of contract.

"Whilst this contract is let in the form of a 'bulk sum contract' the whole of the work 'is to be finally paid for according to the Schedule of prices attached to the Contractor's tender.' Approximate measurements will be made by the Engineer every month for the 'usual monthly estimates, and on the completion of the work, the whole will be accurately measured and paid for at the Schedule prices.'

With regard to the Pictou Railway it can easily be shewn that any difficulties that arose on this line were attributable to the lump sum contract system. The circumstances which bear on the question were these.

Soon after the legislature had decided to build the Railway, the public and intending contractors, more especially perhaps the latter, became exceedingly impatient to have the work commenced, they could not wait until the survey was properly completed. Tenders were actually invited before the line was located. A great number of persons expected or desired contracts. The Province of Nova Scotia had a short time before built about 90 miles of railway connecting Halifax with Truro and Windsor, by the lump sum contract system, and it was notorious that the contractors on this line had succeeded in obtaining large sums beyond their contract prices and thus realized handsome profits.

Contracts on the Pictou Line, were awarded to the lowest bidders and security taken for their fulfilment. The work went on for a time, but it was soon discovered that the prices were altogether too small. The specifications were strict, the system would not admit of extras and the work in consequence came to a stand. This difficulty was clearly the fruit of the system previously adopted in the Province, viz, the lump sum system, and it was felt to be so at the time.

The Government of Nova Scotia subsequently took other means of finishing the Pictou Railway, but it was the lump sum contract which they then entered into, not

the schedule system, which produced such serious controversy in the country and Parliament. It is quite true that in this instance, difficulties were experienced with the schedule system, but these difficulties were clearly the fruit of a bad system which had been adopted on the previous works. Had the lump sum system been adopted at first for the Pictou line, it is believed throughout the length and breadth of the Province that the difficulties would have been increased ten-fold and the total cost of the work would have been greatly enhanced.

Having frankly admitted that there were difficulties on the Pictou Railway where the schedule system was adopted, and indicated the direct cause of those difficulties, I should also state that in advising the Government in November last as to the best mode of proceeding with the work, it was my desire that the Intercolonial Railway should profit by the experience gained on the Pictou Railway. I felt that contractors tendering should distinctly understand from the beginning that the work should be executed in the best manner, that there could be no extras, that everything done should be paid for according to specification and contract *only*, and that nothing should be paid for that was not done. This was the object of the special notice to contractors published with the first specification, and this was the aim and intent of the specifications themselves.

I further suggested to members of the Government other precautions which I thought would be useful in securing competent contractors, and these or similar precautions had they been adopted by the Commissioners would, I am convinced, have secured good men to do the work, and that at prices fairly remunerative, conditions without which the result must be extremely unsatisfactory.

I have not referred to the system of contracts adopted in the building of the Thames Embankment and to which the Commissioners allude. I am, however perfectly satisfied that what I have, in previous letters to you, designated as the English system, is the one which has been adopted. It is the one commonly used in all cash contracts in England, and an exception could scarcely have been made in this particular case. I shall probably, however, be able in a few weeks to satisfy you on this point by furnishing an actual copy of the form of contract used.

The Commissioners also refer to the Pasumpsic Railway and the Hoosac Tunnel in the United States. It could easily be shown that the circumstances connected with these works are entirely different from those which exist on the Intercolonial Railway, moreover these contracts can hardly be considered illustrations of the advantage of the lump sum system, even if the circumstances were alike, until the works shall have been successfully carried out under the contract, and for the original contract sum.

That this system, unless under peculiar conditions has little on the score of economy to recommend it, could be satisfactorily established by reference to its results in different parts of the world, but it is not necessary to go outside the Dominion for some familiar examples. One or two will be sufficient, and I will refer only to those in which large sums of public money, if not of the Dominion, at all events of the late Province of Canada, have been sunk within a very recent period.

The Northern Railway of Canada was originally contracted for at a lump sum per mile, including rolling stock, station accommodation, and everything supposed to be necessary; but before it was well in operation it had actually cost something like double the original contract sum. In a few years afterwards, about three-quarters of a million dollars in addition, had to be expended in rebuilding it and substituting iron bridges for its original perishable structures of timber, which were then in a state of decay and unsafe for public traffic.

The Cobourg and Peterboro' Railway was built mainly with public money, all of which may be considered hopelessly sunk. This line was also built for a lump sum. It proved a disastrous enterprise to the Municipalities which had lent their credit, the whole soon fell into utter ruin, and the greater portion of the line has been abandoned for years back.

The erection of certain Court Houses and Jails in Lower Canada will be well remembered. These too were constructed for lump sums. The Contractors and the

Government were led into all kinds of difficulties, a great deal of time of the Parliament was occupied thereby, and what was originally undertaken under a stringent contract to be completed for \$228,300, actually cost the country \$378,973, or nearly 70 per cent. more than the contract price.

But perhaps the best known and most familiar illustration of the system and its results is the erection of the Parliamentary Buildings and Offices at Ottawa. These, as originally undertaken, under three contracts, were to be built for \$688,595. The actual expenditure, according to the Public Accounts, exclusive of furnishing, &c., amounts to \$2,572,193, and it will yet require an additional outlay, estimated at \$185,000, to complete the main Tower and Library, both of which were originally embraced in the first contracts. These buildings were placed under contract for a lump sum before the most important and indispensable information was obtained with regard to what was really required to be done, and in consequence, what it was originally supposed would cost \$688,595, involved an expenditure of \$2,757,193, or over two million dollars in excess of the original contracts.

No doubt, in the matter of the Parliamentary Buildings, there was much that was exceptional, but the same may yet be said of the Intercolonial Railway before it is finally completed and in operation.

When we find that in all the cases above referred to, the lump sum contracts gave no protection against claims for large additional amounts, and that whether these claims were just or not they were allowed, it seems to follow that this system does not successfully accomplish the object for which it is intended, and that while it professes to afford the actual cost of the work the moment the contracts are let, it would be extremely unsafe to rely upon this as the limit of the public liability. The Commissioners say that with the schedule system "there could be no estimate of what each section would cost until it was completed," but I think it follows from what has already been urged, that this statement is much more applicable to the system of lump sums, with the addition that the public liability is not ascertained even on the completion of the works, and sometimes even not for years afterwards, till the amounts are settled by litigation or arbitration. While, as regards the other system, the amount of liability may be estimated sufficiently close for all practical purposes, soon after the tenders are received.

With regard to the Parliamentary Buildings at Ottawa, I should add that although commenced under stringent lumpsum contracts, it was found necessary after an enormous sum of money had been expended, to pay for their erection by measurement and schedule prices.

If the system proposed by the Commissioners be tried, I apprehend that the same course must, in the long run, be resorted to in the Intercolonial Railway, but unfortunately this will involve an entire change in the contracts, as the Commissioners have expunged from my specification of works all the clauses which are necessary for clearly defining the various classes of work, and how they should be measured, as well as other conditions which I considered necessary to introduce to prevent disputes.

In my previous letters to you, I described the mode in which contracts are let in England. My object was to point out that the schedule system recommended by me was practically the same, (at least, as far as the peculiar circumstances of the case in question would admit), as the system commonly adopted in England, the leading principle in both being that the contractor was assured on tendering for the work that he should be paid at fixed rates and according to clearly defined rules for all the work which he might be required to perform, and for that only.

The Commissioners affirm that I am altogether mistaken with regard to the English contract system, and that the plan proposed by them for the Intercolonial Railway is the one universally adopted.

The Commissioners may be quite correct in this, but it seems most certainly at variance with all the information in my possession.

I have in both my previous letters (January 2nd and January 27th.) described at some length what I conceive the English contract system to be, and I need scarcely do so again at length.

According to my knowledge, it is carried out substantially as follows. After elaborate detail measurements, plans, and calculations are made, and the exact nature and extent of the work intended to be done ascertained, the whole is exhibited to contractors, generally on a schedule which by some engineers is designated "The Bill of Works." The contractor moneyed out the quantities thus given him at his prices, and thus arrives at a total amount; this forms the basis of the contractors tender. If more or less work is actually performed than that shown on the Bill of Works, a corresponding addition or deduction is made at the schedule prices given in the contractors tender.

This, as I understand it, embraces the leading principle on which *Cash Contracts* are commonly let in England, there are doubtless exceptions such as those which I referred to in my letter of the 2nd January last, but as a rule this principle is the one which generally runs through and governs not only in Railway Contracts, but in Contracts for the various other Engineering works executed. Different Companies or Corporations or individuals may vary the mode in which it is carried out, but the principle remains the same.

I have abundant evidence in my possession to satisfy you on this point, the evidence is altogether too voluminous to append to this letter, I shall however be happy to submit it any time; for the present it will be a sufficient illustration to select from a great number, a common Form of Tender and Bill of quantities recently used in connection with a new line of Railway in England, an extension of the London, Brighton and South Coast Railway system.

Copies of these documents are appended to this letter, on examining them it will be found that the Bill of Works embraces 186 different items, all of which must be moneyed out by each Contractor Tendering. At the end of the Bill of Works the following clause will be found. "No Tender will be received unless accompanied by the above Bill correctly priced and moneyed out in accordance with the Schedule of prices," and near the beginning of the Tender it will be seen that the Contractors undertake as follows "to provide all materials and labor and to execute all the works &c., &c., in strict accordance with the plans, sections, drawings and list of quantities exhibited to me (or us) for the sum of £ Sterling, and I (or we) further agree that all additions to and alterations and omissions in the works hereby contracted for shall be valued and paid for, to or deducted and allowed for, by as the case may require according to the several prices set opposite to each description of work in the Schedule of prices hereunto annexed."

I need scarcely say that this form is varied in different cases and by different persons, in some instances the exact work intended to be done is defined in a different way or not so much in detail, in others the precise quantities of every denomination, and in every single portion of the undertaking are given with the greatest possible precision.

For example, I have in my possession the Specification, Form of Tender and Bill of quantities recently used in England in connection with the construction of a Railway less than 20 miles in length. The Bill of quantities is given on 59 printed pages of foolscap, and notwithstanding this extraordinary precision indicating the most careful measurements, prolonged consideration and final determination as to the exact extent of the work intended to be executed in every minute detail, and which one would think might justify, if anything would, a lump sum Contract such as that proposed by the Commissioners for the Intercolonial Railway under very different circumstances,—notwithstanding all this I find the following clauses in the conditions of Contract.

"The Company shall have full power to add to, or take away from, or to alter in any way that they shall think fit, the whole of the works referred to in the Specification, and the accompanying drawings, without any claim upon the part of the Contractor beyond the prices to which he is entitled under his Schedule for work actually performed."

"The quantities shown upon the section attached hereto have been computed from actual measurement of the additional width required, are believed to be correct; The Contractor will however, be paid for the total quantity of excavation actually executed, such quantities to be measured in the cutting and not in the bank."

"The Tender shall be made out and sent in on the form hereto appended, and the total amount shall be based on the quantities supplied to the Contractor, the several descriptions of work being valued at the prices respectively set opposite to each in the List of Prices appended hereto."

"No Tender will be received unless accompanied by the Schedule of prices correctly and fully made up, and no contract will be entered into until it shall have been examined and approved by the Engineer."

"Payments will be made upon the Engineer's Certificate to the amount of 90 per cent. upon the value of the work so measured up from time to time, and actually completed to the satisfaction of the Engineer; the work so measured shall be valued according to the Schedule of Prices attached to the Contract."

"Notwithstanding any custom to the contrary, net measurements only will be allowed and paid for upon all extra works executed, and materials delivered in accordance with the terms of the Contract and Specification, and all prices given in the Schedule attached hereto shall include labor and materials unless otherwise specially specified in the case of any particular item."

"The Contractor to include in his Tender the following works, which may from time to time be required, but the precise nature and position of which cannot at present be defined. In the event of any portion of them not being required, their value calculated by the Schedule of prices, will be deducted from the amount due to the Contractor."—(*Here follows additional quantities not included in Bill of Works.*)

"The Company reserve the right of altering the works in any manner they may think fit, and such alteration shall not invalidate the contract; * * the quantities of work so altered, whether above or below the original quantities, shall be ascertained and valued according to the schedule of prices appended to the tender, and the amount shall be added to, or deducted from the amount of the original tender, and the amount so altered shall be considered and settled as the true amount of the contract."

I could easily furnish additional evidence illustrative of the English system, but I think I have submitted sufficient to convince you that I had some grounds for describing it as I did in my previous letters to you, and that the same principle which in the interest of the Dominion I advocated as the proper one for the Intercolonial Railway contracts is commonly adopted in the mother country in contracts for railways and other works there.

The Commissioners in their paper refer to an engineering question which it is proper I should explain.

The Commissioners are unquestionably right in the opinion that it would be false economy to make the waterways of structures so small that the destruction of the works would follow. This is exactly what I am solicitous to avoid, by asking the Commissioners to wait until the experience of at least one spring freshet will afford some proof that none of the waterways are too small.

Whilst I admit this to be a point of great importance, the Commissioners will, I think, pardon me for desiring on the score of economy to avoid the opposite mistake of making the structures a great deal larger than necessary, or of a character least suitable for the purpose.

The Commissioners seem to have been advised that it is a matter of no great importance as regards cost, what kind of structure is adopted for the passage of the water, and that in regard to culverts, the most judicious plan is to build what are known as Beam Culverts, or open bridges instead of arched openings covered by earthen embankments. They farther seem to have been advised, that when an embankment reaches 40 feet in height it is absolute economy to substitute viaducts with stone or brick piers.

I have long since arrived at the conviction that, in this climate, brick as we ordinarily find it, should not be employed in any form in any railway works not under a roof. I am also decidedly of opinion that there should be no bridge or opening of any description on a railway where the circumstances will admit of a solid embankment being formed. I have arrived at this opinion on grounds which will be readily appreciated, viz. :—

1. An embankment, when once properly made and consolidated, may, humanly

speaking, be considered everlasting, and in this respect far better than any bridge or viaduct, whatever be the material employed in their construction.

2. An embankment, properly consolidated and completed, costs nothing to keep up; whilst bridges require constantly to be looked after, and, if made of perishable materials, to be renewed periodically.

3. An embankment, as a rule, is more economical than a mechanical structure, unless the latter be one of the most temporary and perishable kind.

In proof that an embankment, in addition to its other recommendations, is absolutely cheaper than a viaduct for all ordinary heights and under all ordinary circumstances, I submit the following tabular comparison of the relative cost of an embankment and of a viaduct, each 1000 feet in length, and for various elevations.

The several kinds of work are calculated at ordinary and fair prices in each case, the piers and abutments are of masonry, and to make the comparison complete, in the table will be found the estimated cost of wooden as well as iron viaducts, of various spans as well as heights.

Height of Embankment or Viaduct.	Cost of Embankment.	Iron Viaduct, Spans 100 feet.	Iron Viaduct, Spans 50 feet.	Wooden Truss, Spans 100 feet.	Wooden Truss Spans 50 feet.
Feet.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
30	21,000 00	94,360 00	84,064 00	62,666 00	63,264 00
40	34,666 00	106,610 00	101,452 00	74,160 00	79,056 00
50	51,666 00	119,392 00	119,946 00	86,060 00	95,688 00
60	72,000 00	132,706 00	139,798 00	98,744 00	114,210 00
70	95,666 00	146,748 00	160,952 00	112,030 00	133,768 00
80	122,666 00	161,420 00	183,702 00	125,946 00	154,922 00

From this it will be seen that the net cost of an embankment 40 feet high and 1,000 feet in length is under \$35,000, whilst a viaduct with a wooden superstructure on stone piers would cost from \$74,000 to \$79,000, or more than double.

As to the relative durability of a solid embankment and of a timber structure, or the economy of maintaining them, there really can be no comparison.

To show that it is really a matter of some consequence, that the fullest information respecting the greatest volume of water in streams should be obtained before the character of structures is determined on, and that it is not at all consistent with true economy, either to act in a haphazard way, or on the principle of erring on the safe side, by making all the waterways much larger than necessary, I will now show the comparative cost of structures of various kinds.

Taking a 40 feet embankment, and calculating the quantity of masonry in each, at the same price per yard, the comparative cost would be as follows.

A box culvert, 2 ft. 6 in. by 2ft. 6 in.	\$1,280
An arch culvert, 4 ft. span, by 5ft. 9 in. high in the clear	3,330
An arch culvert of 6 ft. span by 7 ft. high	4,170
An arch culvert of 10 ft. span by 12 ft. high	7,400
A beam culvert, two vertical walls with stringers of timber	17,500

These figures show very clearly that the size of a stream is a question of no little importance, and one which cannot very well be disposed of, simply by making all the structures of one size and character. If a stream were such that a culvert costing \$3,330, would allow ample passage way for all the water that will ever in the course of nature run through it, it would be unwise and wasteful to build a culvert that would cost \$4,170 or \$7,400, still more so to erect a structure that would cost no less a sum than \$17,500.

Again, if we take very small streams, those for which under any circumstances, a clear waterway of 2 ft. 6 in. square would be quite large enough, and make an estimate of the cost of a culvert of this size for different heights of embankment, and make a comparison with the cost of an open beam culvert for the same heights of embankment, we shall see the following very striking differences.

Height of Embankment.	Open Beam Culvert.	Box Culvert.
5 feet.	\$430	\$310
10 feet.	1,010	480
20 feet.	4,040	810
30 feet.	9,200	1,113
40 feet.	17,500	1,280

If these calculations are well founded, it will be obvious how important it is, before coming to any decision as to the size and character of a bridge or culvert to be adopted, at any given place, to be in possession of the information upon which alone such a decision could safely be based. If made too small the cost is entirely lost, and the reconstruction more expensive than building it of the right dimensions in the first instance, while if built unnecessarily large, the loss is much greater than without accurate calculation could be supposed. An excess in either way is great want of economy and should be avoided if possible.

Although it may seem of little or no consequence to a non-professional man, what kind or character of structure is erected, the above will satisfy you, and I am glad the Commissioners have raised the question, that it is really a matter of very grave importance. You will readily perceive that the fullest possible information respecting what the circumstances of each case requires, should first be obtained before the character of the structure should be finally decided on, and until this is done, until what is wanted is known, no contract should be entered into, except one on the principle of the schedule system.

I have now made all the observations I consider necessary respecting the statements which the Commissioners were pleased to submit to the Government, in reply to my un-official letter to you, dated January 2nd last. I need scarcely say that my opinion remains unchanged with regard to the principle upon which the contracts should be based. There is one point however which I should allude to before closing this letter, and it is this: Tenders consisting simply of a schedule of prices and no more, would not on the face of them give any idea of the probable cost of the work to be done, and although I have shown how the relative value of tenders of this kind may become truly ascertained, I admit that a considerable number of them would cause some delay in making the computations and comparisons. If this be an objection it could easily be removed by furnishing contractors with a statement of quantities made up roughly from the best data obtained, such as the approximate estimates in the possession of the Commissioners, and requiring each party tendering to money out these quantities each with his own prices, exactly as in England. This would transfer to the contractors the operation of calculating the amounts, which, under the first plan, would be done by the clerks in the Commissioners Office.

I would farther suggest, that although it is impossible with our present information, to prepare a statement of quantities with any pretensions to accuracy, every care should be taken that the quantities furnished contractors should be ample to cover every possible contingency, that they should in fact be *maximum quantities*.

If this were done, not only would the Commissioners on receipt of the tenders be able to judge of their relative value, but both them and the Government would know the *maximum liability incurred* by each contract. It would then be the duty of the Commissioners and the Engineer to take advantage of information gained by farther surveys and of every circumstance which would tend to reduce the quantities actually executed in the work without impairing its efficiency. The contract would provide for this as in the English contracts, and the contractor would be paid for all that he actually performed at his own prices, and for that only.

This modified plan of carrying out the Schedule system in connection with the Intercolonial Railway is, I think, worthy of consideration, it would meet fully the only objections raised by the Commissioners, while it would avoid the perplexing difficulties to which the lump sum system will be sure to lead, and which I have so frequently alluded to in my previous letters.

It is just possible that I may over rate these difficulties or perhaps looking at the matter from an Engineer's point of view, I may see difficulties which may not strike with equal force the minds of persons who have not practically had to deal with such questions professionally; be that as it may, I would have considered myself wanting in my duty to the Government, had I not laid before you my honest convictions on matters which I conceive of great public importance.

In conclusion I may say that if I have urged the views I hold with earnestness and vigor, it is because I am strong in my opinion of their soundness.

Having done so I shall have discharged my duty, but I shall consider it equally my duty faithfully to carry out to the best of my ability any system which the Commissioners with the sanction of the Government think fit to adopt.

I shall certainly not allow my preference for any other system to interfere in the slightest degree with my making every effort to give effect to the wishes and views of the Government, so as to give the system adopted, whatever it may be the fullest opportunity of success.

I have the honor to be Sir,

Your obedient Servant,

SANDFORD FLEMING,

Chief Engineer.

Intercolonial Railway Office,
Halifax, March 10th, 1869.

EXTRACT from the published Report of the Directors, Great Western Railway of Canada, dated September 29th, 1854, referred to in Mr. FLEMING's letter of 10th March, 1869, to Sir JOHN A. MACDONALD, K.C.B. (See foot note, page 14.)

"The total cost of the line and plant having so much exceeded all previous calculations, the Directors will endeavour to explain the causes which led to this large increase of cost.

"The original estimate of the line was made several years ago, when the price of labor, materials, land, and everything relating to the construction of a railway was extremely low in Canada. It appears that the estimate was framed upon the assumption that the line starting from the Falls of Niagara, about 100 feet below the level of Lake Erie, would keep on that level, and so have not much rise to overcome in reaching the Detroit River. It seems also, that no detailed surveys and estimates of quantities was then made.

"A year or two after this, the then Engineer reported that he thought the line could be carried through for the sum originally estimated.

"It appears that even at that time no detailed and accurate surveys and measurements had been made, as many parts of the line were not even finally located, but the engineer was instructed to show in detail the exact cost of every part of the line. It is necessary here to mention that in 1851 and 1852, contracts for the construction of the whole of the line had been let to various parties, based upon plans and profiles made at that time, and containing stipulations that the contractors would proceed with the works when ordered to do so, these contracts will be hereafter referred to.

"The above mentioned Report was received in September, 1852, and shewed that the cost of the line, exclusive of land, interest, management, &c., would exceed the first estimate by about £300,000 currency. It had always been understood that the Great

Western Railway would be nearly as easily constructed as the lines in the prairies of the west, and that its cost would therefore bear something like a proportion to the cost of those Western Railways, but such turned out not to be the case, as will appear from the following extract from a Report made in June, 1853, by the then Engineer of the Company, viz.:

"From a pretty large experience, both professionally and as a contractor on public works, I had supposed myself familiar with many hard and difficult points of execution, but I am fully satisfied that with the exception of rock excavation, more difficult obstacles and inveterate, and extended in their character, are seldom found even on as extended lines as the Great Western, than are encountered between Niagara Falls and Windsor."

"In proof of this it may be remarked that the original design of the line to keep on the high grounds, 300 to 400 feet above the level of Lake Ontario, was changed, and it was determined that the line should strike the Lower Lake at Hamilton. To accomplish this, the line is brought gradually down the side of what is termed the mountain which forms, it is supposed, the original boundary of Lake Ontario. The works on this part of the line are very heavy indeed, as appears from a return of the cost of the first 18 miles from Niagara Falls, this portion without land, rolling stock, or any charge but the mere cost of the line itself, has reached the large sum of £17,900 currency per mile. This brings the line to the level of Hamilton, where extensive station grounds, with large water frontage, have been secured (about 30 acres), which were once covered with water and have now been filled in with earth, from Hamilton the line rises about 800 feet above the level of Lake Ontario, and for about 30 miles has very heavy work indeed."

"The cost of 24 miles of the line from Hamilton Westward, again exclusive of land, Rolling Stock, &c., has reached £21,500 currency per mile."

"The contracts before alluded to and under which the line has principally been constructed, must now be explained, first premising that in their general features they are similar to most railway contracts in America, upon the model of which they were framed by Engineers and others who have been concerned in the construction of railways in that country. These contracts are wholly dissimilar to English contracts they specify no defined sum which the works are to be constructed for, but the price is fixed in this way. They contained clauses which provide that the different kinds of work shall be executed at certain prices per yard, no word being said about the whole quantity or gross number of yards comprised in each Contract, for instance, the contract runs thus:

" For indurated earth ()	cents per yard, measured in excavation.
" Common "	" " " "
" Hard fan "	" " " "
" Rock "	" " " "
" Masonry	dollars per yard
" Brickwork	" " "
" Bridging	" " 1000 ft. B. M.

"and so on for all the different kinds of work which the contractor may have to execute on forming the part of the line let to him."* The paying of different prices for different kinds of earth is obviously a bad one, because disputes almost impossible of a clear and satisfactory solution invariably arise as to the exact quantities of the different kinds of material, but it must be at once obvious that the only proper guide with such contracts as to the whole cost of the line must entirely depend upon accurate measurements of the quantity of work to be performed.

"After the Engineer's Report of September, 1852, before referred to, a change took place in the Engineering Department, and in June, 1853, the then Engineer

*—** This portion only is quoted by the Commissioners in their paper dated 26th January, 1869.

made a report in which he stated he had caused careful estimates to be made of the different kinds of work throughout the entire line and handed in detailed estimates of the quantities and cost of every part of the line—the cost being based upon the prices contained in the contracts, his report showed that the aggregate cost of the line would, according to his calculations, exceed the estimate rendered in September, 1852, by about £340,000 currency. It was about this time that an extraordinary advance took place in the cost of labor, provisions, materials, land, and indeed almost everything in Canada, and this had a very important and unfortunate effect upon the cost of Great Western Railway. Contractors in Canada are (necessarily) in most cases men of small capital, and it is clear that unless they get remunerative prices for their work they are unable to carry it forward, because they depend upon being able to pay their men, buy provisions for the men and horses, purchase materials and implements out of the money they monthly receive from the Company on account of the estimates of the work they have done. The result of this is that when a contractor failed as many of them did, the only course to pursue was to relet the works at prices which would enable them to be carried on. This applied peculiarly to all mechanical work, such as masonry, bridging, &c. The wages of skilled labourers having risen to an enormous price, as also the price of timber and iron.

"It must also be mentioned that in many instances the character of the mechanical structures has been much improved, thereby adding to the cost.

"It is easily to be seen how these various facts tended to increase the cost of the line, but in addition to this it now appears that the estimated quantities of work fall in many cases considerably below the actual fact.

"For instance it now appears that the earthworks was short estimated by about 600,000 yards.

"In the item of bridging there has been an under estimate of upwards of 2,300,000 feet

B. M.

"The cost of the station buildings will exceed the estimate by about \$60,000.

"In superstructure that is the cost of iron, sleepers, spikes, &c., and laying them there has been a very large increase. In the early estimates the rails were put down at the first cost in Wales, and no allowance made for transportation, insurance or duties. In the report of June, 1853, the Engineer endeavoured to remedy this omission and made out what he supposed then to be liberal allowances for these items. But his calculations have been greatly upset by the large increase in price before referred to, as having taken place in Canada towards the close of last year. The necessity for delivering the iron at various different points, making it necessary to cart it along miserable roads from the various ports on Lake Erie, Ontario, and St. Clair, to the line of railway, added very largely to the cost under this head. The extent of siding estimated in June, 1853, turns out to be far below the absolute requirements of the traffic, it was then estimated that 17 miles of sidings would be sufficient, but as there are now 33 stations, with the certainty of a very large freight traffic, it is perfectly clear that far more will be needed.

"It appears again that it is not usual for Engineers in this country to add a percentage to their estimates for extras or contingencies, but the fact shews that extra bills which could not be avoided and which could not have been estimated except in the shape of contingencies, have been passed by the Engineer to the amount of upwards of \$300,000.

"The cost of the land is another item of increase, arising to a large extent from the great progress of the country and the prospects of large traffic, shewing the necessity of requiring more land at stations than was at first anticipated. The cost of land was first estimated at about £20,000. It will cost in all about £175,000 currency.

"The next important item is that of rolling stock where a very large increase has taken place. It will need no explanation to point out that this expenditure, when really necessary, as in this case is the best expenditure than can be incurred.

ENGLISH Form of Tender referred to in Mr. FLEMING's letter of 10th March, 1869, to
Sir JOHN A. MACDONALD, K.C.B.

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

SOUTH LONDON, TOOTING, AND SUTTON JUNCTION LINES.

TENDER FOR WORKS.

To the Directors of the London, Brighton, and South Coast Railway Company.

GENTLEMEN,—

I (or we) _____, of _____ do hereby agree and undertake to provide all the materials and labour, and to execute all the works required in the construction, completion, and maintenance of the intended new Line of Railway between Peckham and Sutton, including the intermediate Junction Lines, and the alteration of the Croydon and Wimbledon Line, being a total length of eleven miles and seventy-eight chains, or thereabout, within the time and upon the terms and conditions stipulated in the specification, and in strict accordance with the plans, sections, drawings, and list of quantities exhibited to me (or us) for the sum of £ _____, say _____ pounds sterling.

And I (or we) further agree that all additions to, and alterations and omissions in the works hereby contracted for shall be valued and paid for to _____, or deducted and allowed for by _____, as the case may require, according to the several prices set opposite to each description of work in the Schedule of prices hereunto annexed.

And, in case this Tender shall be accepted, hereby undertake to execute a contract deed, to be prepared by your solicitor in accordance with the terms of the aforesaid specification, within two weeks from this date, or as soon thereafter as may be required by you so to do.

And we propose Mr. _____, of _____, and Mr. _____, of _____, as sureties for the due performance of such contract.

And, further, undertake that they shall, within one week after receiving notice from you so to do, execute a Bond, to be prepared by your Solicitors conditional for that purpose in a penal sum equal in amount to 10 per cent. on the said sum of £ _____.

And, lastly, _____ do hereby agree and undertake that in case said contract and Bond shall be executed by _____ and _____, said two sureties, within the time above mentioned, the London, Brighton, and South Coast Railway Company shall not (unless they think fit) be bound by this Tender and Contract, but the same shall be absolutely null and void if so desired by the said Company, nor shall they in such case be liable to any claim from _____ in respect of any works then already done, or of materials and plant then delivered by _____ upon the site of the intended contract.

And witness _____ hand this 3rd day of January, 1865.

Contractors' signature _____

Address _____

SOUTH LONDON, TOOTING, AND SUTTON JUNCTION LINES.

BILL OF QUANTITIES.

Being an approximate estimate of the total quantities of work required in the execution of the above contract, from which the aggregate amount of the foregoing Tender has been computed.

			£ s. d.
45,000	lineal yards....	Larch post and four rail fencing	
8,500	do	Larch post and three rail fencing	
500	do	Rough six feet larch palisade fencing	
500	do	Rough six feet close board fencing	
1,100	do	Oak park paling, with oak coping 5 feet high	
1,000	do	Oak park paling without coping 5 feet 6 inches high	
1,400	do	Open wrought and painted iron fencing, Thumming & Son's make	
3,500	do	Wrought paled and painted 4 feet 6 inches fencing	
350	do	Wrought paled and painted 6 feet fencing	
2,600	do	Wrought oak and fir rail	
53,000	do	Ditch mound and quick sets	
20	No.	Wrought and painted oak field gates	
10	do	Wrought wicket footgates	
20	do	Wrought and painted paled 12 feet gates 6 feet high	
10	do	Wrought and painted paled 3 ft. 6 in. gates 4 ft. 6 in. high, at	
826,300	cubic yards	Excavation for double line of way throughout including the	
		alteration of the Croydon and Wimbledon line	
35,000	do	N.B. This quantity is fixed (see spec., page 11.)	
40,000	do	Extra excavation for stations and other purposes	
20,000	do	Excavations in diversions of streams and roads, and in sunk	
118,000	do	approaches to bridges	
5,000	do	Excavation for foundations, sewers, culverts, and drain pipes	
620	lineal yards	Extra upon earthwork in embanked approaches to bridges	
500	cubic yards	Extra excavation in tunnels	
300,000	superficial yards	Fencing Severn bank at Mitcham including trimming, soiling	
137,000	cubic yards	and planting (see specification, pages 15 and 16.)	
400	do	Dry rubble drains at back of walls and bridges	
5,000	superficial yards	Trimming and soiling slopes of cuttings and banks	
100,000	do	Ballasting permanent way of main line and sidings	
9,000	do	Covering girder bridges with ashes or cinders	
42,000	cubic yards	Metalling road, approaches, and yards 18 inches thick (large	
13,000	do	stone in both 9 in., flint and gravel 9 in.)	
600	do	Metalling road, approaches, and yards, large stone 6 in. flints	
1,000	do	6 in.—12 inches	
1,200	do	Metalling road, approaches, and yards, 4 in. coarse gravel and	
775	lineal yards	chalk, 4 in. screened gravel	
150	cubic yards	Best stock brickwork in grey lime mortar	
500	do	Best stock brickwork in blue lias mortar	
12,000	superficial yards	Best stock brickwork in Portland cement	
500	do	Best stock brickwork in culverts and sewers	
2,000	do	Best stock brickwork in extra thickness in tunnels	
8,000	do	Tunnels driven, lined, and drained completely, as per	
300	superficial feet	specification	
2,000	do	Extra gault bricked in lining tunnels	
7,000	lineal yards	Old brick felled down, including all expenses of shoeing, &c.	
7,000	do	Face work of picked red stocks, tuck pointed in black	
2,000	do	Face work of white Suffolk malms—Tuck pointed	
8,000	do	Face work of picked Huntingdon or Southall white bricks	
300	superficial feet	Tuck pointing only	
2,000	do	Cut and nibbed work in arches and groins	
7,000	lineal yards	Gauged arches set in putty mortar	
7,000	do	Bevelled plinth courses set in cement tuck pointed	
2,000	lineal feet	Moulded white or red brick cornices, plinths, neck mouldings, &c.	
150	do	Nail head brick courses, white, black, or red	
		Dogtooth do do	

BILL OF QUANTITIES.—Continued.

			£ s. d.
92	No.	Terra Cotta arch keys (P. C. 30), each	
83	No.	Terra Cotta medallions (P. C. 25), each	
4,200	lineal feet	Terra Cotta open parapets (P. C. 5), per foot lineal	
1,000	lineal yards	Staffordshire blue brick coping for parapets, 14 inches by 4½ inches	
700	do	Staffordshire blue brick coping for parapets 18 inches by 4½ inches	
1,600	do	Staffordshire bullnosed blue brick coping for platform 14 inches by 6 inches	
1,000	do	Drain pipes 12 inches diameter, including bends, &c.	
2,500	do	do 9 do do do	
1,000	do	do 6 do do do	
1,200	do	Half round pipes 9 do including bends, &c. laid in puddle	
5,000	cubic feet	Bramly Fall stone in imposts, including plain face work	
28,000	do	Hollington stone, ashlar, and other work, including plain face work	
20,000	do	Bath stone coping, caps, strings, &c. including plain face work	
12,000	superficial feet	Moulded and circular tooled work (labour only)	
500	do	Yorkshire self faced paving 3 inches thick	
20	No.	Extra labour on spherical finials	
500	lineal feet	Chamfered and tooled joints	
1,000	superficial yards	Granite pitcher paving	
2,000	lineal feet	Purbeck stone curbing 12 inches by 6 inches	
500	do	Granite stone curbing 12 inches by 9 inches	
6,500	cubic yards	Concrete in foundations	
3,000	do	Concrete in backing and counterfoils	
12,000	superficial yards	Coating arches with asphalt and fill one inch thick	
9,000	do	Raking out and pointing soffit of arches	
6,000	cubic feet	Memel timber in sleepers, nailing joists and creosoted and fixed	
2,500	do	Memel timber in guage and sheet piles, creosoted, hooped, shod, and driven, including iron work	
5,000	do	Ditto, including longitudinals and joints burnettized and fixed	
2,000	do	Ditto, wrought, framed, painted, and fixed	
23,000	superficial feet	Three inch planking burnettized and fixed	
700	lineal feet	Moulded oak coping to parapets 9 inches by 4 inches, painted and fixed	
5,000	superficial feet	One inch matched and beaded boarding wrought and fixed	
390	tons	Cast iron work in heavy castings fixed and painted	
130	do	Ditto on light castings fixed and painted	
650	do	Ditto on ornamental castings fixed and painted	
850	do	Wrought iron in girders, joists, &c. fixed and painted	
20	do	Ditto, in bolts, straps, ties, &c. fixed and painted	
1,300	superficial feet	Galvanized corrugated iron, No. 18 guage, fixed in parapet	
3,000	do	Ditto, curved and fixed as being on rest posts of tunnel	
2,000	superficial yards	Painting two coats in plain colours	
1,000	do	Bronzing iron work, including two first coats plain	
5	tons	Lec in joints, flashing, &c.	
1,500	superficial feet	Croggon's patent asphalted felt 1 inch thick	
45,000	lineal yards	Single line of permanent way laid complete	
11,000	do	Intermediate way laid complete	
40	No.	Sets of points and crossings laid complete (laying only)	
10	do	Ditto, three throw and crossings, ditto	
10	do	Diamond crossings ditto	
20	do	Single ditto	
12		Months maintenance of the whole of the works after completion and opening for public traffic	
Total			

BILL OF QUANTITIES.—Continued

d.	—	—	£ s. d.
		PROVISIONS. Contractor to provide as follows, viz. : For carving in stone to ornamental bridges viaducts and tunnel fronts For extra cost in patterns of ornamental works For carrying works over and under other railways For removing and rebuilding over Leigham Lane For alteration of bridges under York Road near Lower Norwood Station For diversion of traffic on Croydon and Wimbledon Line, including watching and signalling during progress of the works For preparing copies and detail drawings For taking borings or sinking trial holes For setting outworks and giving levels For office for Inspectors For temporary roads and access to works For watching, lighting, and signalling For interference with and making good all existing gas and water manes or pipes and all culvert sewers and drains For obtaining approval of new or altered roads and approaches For fees to local boards, vestries, and surveyors For clearing the ground as specified For law costs of contract and bond For taking out quantities and measuring up works For printing and lithography For all other contingencies whatsoever TOTAL AMOUNT OF TENDER	

N.B.—No tender will be received unless accompanied by the above bill correctly priced and moneyed out in accordance with the schedule of prices.